Drinking Water Treatment and Distribution

Drinking-water treatment includes physical, biological, and chemical processes to make water suitable for potable use. Distribution includes the storage, pumping, and pipe systems to protect and deliver the water to the customers. Even after preventing pollution and matching water quality to use (see preventing pollution and matching water quality to use strategies), drinking water supplies will generally still require some of level of treatment to achieve a potable level of quality, which will then need to be maintained in a distribution system. Widespread treatment of drinking water, especially disinfection and fluoridation, was one of the great public health advancements of the 20th century.

Current Status of Drinking Water Treatment and Distribution in California

The state of California has a role in ensuring the safety of the public water supply and the health of Californians who use it. Pursuant to State Department of Health Services regulations, all surface waters in California must be filtered and disinfected, except for a small number, like San Francisco's Hetch Hetchy water supply, that meet DHS's "filtration avoidance" criteria.[1] In general, basic surface water treatment consists of pretreatment (primarily sedimentation), filtration through sand and gravel followed by disinfection with chlorine. Many water suppliers have already implemented more advanced treatment to improve water quality using processes such as granular activated carbon (GAC) for filtration and ozone and chloramination (a combination of chlorine and ammonia) for disinfection.

In southern California, the Los Angeles Department of Water and Power has disinfected Owens Valley water with ozone for the past 20 years. The Metropolitan Water District is upgrading to ozone disinfection at its five treatment plants, which use either Delta water exclusively, or a blend of Colorado River and Delta water. UV radiation is a promising advanced disinfection technology, but has yet to be implemented in a large-scale domestic water treatment plant in California. The integration of multiple disinfectants also shows promise in optimizing protection from microbiological contaminants in drinking water. Some smaller water treatment plants use membrane filtration, which produces relatively high quality water. The waterworks industry is exploring the feasibility of point-of-entry (POE) and point-of-use (POU) devices, which would treat only that water used for domestic purposes, and which could provide relatively quicker and more cost-effective water quality improvements. Water systems that rely upon groundwater generally only disinfect well water with chlorine, unless a specific contaminant is affecting the water's intended use.

Distribution system water quality is emerging as an important issue in the waterworks community, especially given recent heightened awareness of water supply security. Historically, treated water storage and associated distribution systems were designed to meet fire suppression flow requirements rather than maintain system water quality. Threats to water quality in distribution systems include the introduction of contamination from cross-connections with non-potable water sources (such as recycled water), open treated water distribution reservoirs, and water main repair and replacement, as well as lead, the by-products of corrosion, and regrowth of microorganisms. Ironically, the implementation of ozone for disinfection, while effective in killing microbes, reducing objectionable tastes and odors, and generally forming fewer disinfection byproducts, can create conditions that can encourage the growth of

[1] Please refer to Volume 1, Chapter 2, for the legal and regulatory framework for drinking water treatment and distribution.

microorganisms in water distribution systems. Aging water system infrastructure--some well over 100 years old--in general is not being replaced or rehabilitated within the useful life of such facilities. Small, rural water systems (i.e. those serving fewer than 3,300 service connections) face unique treatment and distribution challenges, primarily due to the lack of technical and financial capacity to adequately address water contamination. Such systems are often the most frequent violators of drinking water standards, and often must cope with some of the most difficult water quality constituents, such as arsenic, as well as more traditional but no less problematic contaminants such as nitrate and coliform bacteria.

Potential Benefits

Improved water quality can directly improve the health of Californians, thereby improving the state's standard of living and reducing the burden and costs on the state's healthcare system. Many water contaminants potentially cause cancer, nervous system and organ damage, developmental impairments, and dysfunction of the reproductive and endocrine systems; others can cause short-term gastrointestinal illnesses, resulting in lost work and school days. If poor water quality causes a need for medical treatment by many uninsured Californians, the costs will be borne by state health programs, such as MediCal, which directly impacts the state budget. In addition, many consumers who choose to purchase relatively expensive bottled water or home treatment units, could save more of their personal budgets if they instead used safe tap water.

The U.S. Environmental Protection Agency has proposed new regulations to reduce both the gastrointestinal and carcinogenic disease risks of drinking water. The agency estimates that the Long Term 2 Enhanced Surface Water Treatment Rule will prevent more than 1 million cases of cryptosporidiosis (a gastrointestinal ailment) and up to 140 premature deaths annually, providing $1.4 billion in benefits. EPA also estimates that the Stage 2 Disinfection Byproducts Rule will prevent up to 182 cases of bladder cancer per year, providing nearly $1 billion in benefits. The combined costs of these two proposed regulations are less than $24 per year for most households.

Potential Costs

Advanced water treatment itself is a relatively low percentage (on the order of one percent) of a customer's overall water bill. For example, the 40 million gallon-per-day North Bay Regional Water Treatment Plant, which serves Fairfield and Vacaville, treats a blend of Lake Berryessa and Delta water with GAC filtration and ozone. The operations and maintenance expenses of these processes cost $0.04 per 1,000 gallons, on a total metered charge of $3 per 1,000 gallons. As another example, the Metropolitan Water District of Southern California estimates that its capital upgrade to ozonation will cost about $83,000 per acre-foot per day of capacity, with operations and maintenance costs of $9-$12 per acre-foot (equal to $0.03 to $0.04 per 1,000 gallons). Nonetheless, despite the relatively low costs, economies of scale negatively affect small water systems that have a smaller rate base to spread both capital and O&M expenses.

As for infrastructure, the American Society of Civil Engineers (ASCE) recently gave a grade of "D" to drinking water infrastructure, in its 2003 Progress Report for America's Infrastructure. EPA estimated in October 2002 that over the next 20 years, there would be a $535 billion funding gap nationally for water and wastewater infrastructure. The drinking water estimate alone was $265 billion, covering both capital and operations and maintenance costs. In November 2002, the Congressional Budget Office issued its own estimate of at least $25 billion (2001 dollars) annually for the same time period, consistent with

EPA's figures. EPA estimates California's drinking water infrastructure needs at approximately $1 billion annually over the next 20 years. EPA also predicted that per household costs to small water systems will be four times that of customers of large water systems -- those serving more than 50,000 persons.

Major Issues

There are several major issues facing drinking water treatment and distribution.

Access to Safe Drinking Water

The provision of safe drinking water is a fundamental preventative public health measure. DWR's recent report *Californians Without Safe Water,* found that over 81,000 California households may rely upon an unsafe source of water. In lieu of a connection to a public water system, many of these households may be obtaining their drinking water from shallow wells, springs, or hauled water supplies that are vulnerable to contamination. Moreover, many other households and schools, often in rural or low-income areas, are connected to small water systems that are less scrutinized by regulatory agencies. These small systems usually have limited funds and staffing to pursue improvements in drinking water quality, including the preparation of grant applications. Even for those households that are connected to a public water system, DHS reports that in 2001, over 40,000 people were served water from public water systems that had repeated violations of the coliform bacteria drinking water standard, and that over 700,000 people were served water in violation of the surface water filtration and disinfection regulations. In addition, nearly one million Californians were served water in 2001 from public water systems that had a "significant sanitary defect involving sewage."

Emerging Contaminants

New contaminants are often discovered and then regulated because of increased pollution, improved analytical abilities, and better understanding of health effects. In addition, the health effects of many known contaminants are re-evaluated--and re-regulated--in light of new information. For many emerging contaminants, there may not yet be treatment technologies available to remove them from drinking water. In fact, emerging contaminants may be created by treatment itself, for instance, when water utilities implement new methods or processes for disinfecting water. For such contaminants, only pollution prevention, or matching water quality to use, will adequately address water quality. For other contaminants, treatment options, such as membranes, may be available, but they are relatively expensive.

Risk, Demographic Changes

There are increasing numbers and proportions of immunocompromised individuals--as well as children and elderly--who are more susceptible than the general population, to the risks of waterborne disease and exposure to contaminants. At the same time, water agencies are responding to regulatory signals that require control of disinfection byproducts in treated surface water. Depending upon the treatment scheme employed, measures to reduce the probable long-term risks of cancer can be at odds with efforts to protect the public from known short-term risks from microorganisms.

Contaminant Interactions and Cumulative Effects

There is growing concern about the interactions and cumulative effects on human health of multiple contaminants in drinking water. Such effects are not addressed by current drinking water standards, which only regulate contaminants on an individual basis. Moreover, some contaminants, such as disinfection byproducts, present risks simultaneously through multiple exposure routes (e.g. ingestion, inhalation, and dermal). The CALFED Drinking Water Quality Program is attempting to address this concern via its

"Equivalent Level of Public Health Protection" strategy, which looks comprehensively at the total concentration of contaminants in drinking water, and integrates pollution prevention, alternative water sources and facility re-operation, and advanced treatment to reduce them.

Recreation

The state Department of Parks and Recreation forecasts an increasing demand for recreation on reservoirs, including drinking water terminal reservoirs, such as Lake Perris in Southern California. An increase in reservoir contamination, especially microbiological from body-contact recreation, can correspondingly increase the requirements of the treatment processes, in the treatment plants that a drinking water terminal reservoir feeds, and degrade the quality of tap water produced from these lakes.

Public Distrust

Public opinion surveys consistently suggest that Californians, across all socio-economic groups, poorly perceive and even distrust the quality of their tap water, often because of tap water taste, odor, or appearance, choosing instead to rely upon home treatment units and bottled water. Quite simply, improvements in water quality may not lead to improvements in public health if the public is not drinking the water. While some amount of bottled water use is certainly related to convenience or lifestyle choices, the poor perception of tap water is certainly a factor as well. However, the public may not have access to complete information about the relative safety of bottled and tap waters, and may be misplacing their trust in sales pitches for bottled water and home treatment units. Furthermore, students may be bypassing tap water in schools—when it's even available—in favor of less healthy beverage alternatives.

Affordability

Even though water treatment is a relatively small portion of a customer's water bill, increased costs are a concern for significant portions of the population. As costs increase, the relative burden on the household budgets of poor families will increase at rates greater than that of the general population. Moreover, the waterworks industry generally lacks lifeline rates for poor customers relative to other utilities, such as gas, electricity, and telephone. Paradoxically, for those economically disadvantaged consumers who choose to purchase bottled water, money spent on that commodity may be better spent on other life necessities.

Recommendations to Improve Drinking Water Treatment and Distribution

1. All Californians should have access to safe drinking water. Thus, the state should assist in funding drinking water and wastewater infrastructure needs in areas--including on tribal lands--without piped domestic water and therefore not covered by the state and federal Safe Drinking Water Acts. Further, the state should implement the recommendations of DWR's 2003 report, *Californians Without Safe Water*.
2. The state, local water agencies, and non-profit organizations should better educate the public about the actual and perceived risks of tap water, bottled water, and water produced by home treatment units. State and local water agencies should specifically improve outreach to and communication with vulnerable populations that may indeed be at a higher actual level of risk of waterborne disease or other health effects from drinking water contaminants. Doctors and other healthcare professionals, in whom the public may place their trust, should be involved in this effort.
3. Communities should have useful access to, knowledge of, and engagement in, drinking-water quality monitoring and assessment. In addition, decision-making at all government levels should be

transparent and involve affected communities, tribes, and general purpose local governments. Examples of vehicles for such access, knowledge, and engagement include citizen water quality monitoring programs, and water quality community advisory committees, at the local water system level.

4. The state should consider increasing the set-aside capacity building within the Drinking Water State Revolving Fund to the maximum allowed by EPA for these purposes. Systems that serve large proportions or numbers of vulnerable populations, such as schools, should receive funding priority. The state should increase its formal partnerships with non-governmental organizations that are experienced in assisting small water systems in grant and loan applications, in order to reduce the bureaucracy separating community access to information and funding, address the most pressing public health risks, and ensure an equitable distribution of grant and loan funds.
5. The state should implement guidelines for the design and operation of distribution systems to maintain system water quality. As a part of these guidelines, the state should ensure that public water systems are prepared for natural and man-made disasters, and are able to reliably maintain or quickly restore water quality in the aftermath of such disasters.
6. Water utilities must prevent possible cross-contamination of potable water from dual-plumbing of potable and recycled water distribution systems and other non-potable sources.
7. In response to continuing, legitimate concern from citizens, the state should monitor and resolve the potential health impacts of indirect potable reuse of recycled water.
8. The State Water Project and local agencies should only permit forms of recreation on terminal reservoirs that do not endanger the public health of those who drink the water produced from those reservoirs.
9. The state should coordinate its funding sources (e.g. the Drinking Water and Clean Water State Revolving Funds) in order to better address projects with multiple benefits – such as drinking water supplies threatened by contamination from septic systems. State water quality funding sources for small water systems should be closely coordinated with federal water quality monies, including funds available from the US Department of Agriculture.

Sources of Information

- *Bay-Delta Water Quality Evaluation*, California Urban Water Agencies, June 1998
- *Drinking Water into the 21st Century; Safe Drinking Water Plan for California, A Report to the Legislature*, California Department of Health Services, January 1993
- *Californians Without Safe Water, California 2002,* Department of Water Resources, 2002
- 2000 US Census
- USEPA Drinking Water Program, www.epa.gov/safewater/
- USEPA Needs Survey, www.epa.gov/OGWDW/needs.html
- Congressional Budget Office, www.cbo.gov/execsum.cfm?index=3983&from=1&file=ExecSum.htm
- Water Infrastructure Network, www.win-water.org/
- City of Fairfield
- Metropolitan Water District
- California Department of Parks and Recreation
- ASCE 2003 Progress Report for America's Infrastructure